Testimony Stricken per Oral Ruling on August 27, 2018
and as shown in red strikeout text

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DWR-1211
Revised

BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX

TESTIMONY OF SHAWN ACUÑA

I, Shawn Acuña, do hereby declare:

I. INTRODUCTION

My name is Shawn Acuña, I am a Senior Resource Specialist for Metropolitan Water District of Southern California. I have over 15 years of experience in fish biology and environmental science. I received a B.S. in Aquatic Biology (1998) at the University of California, Santa Barbara. After several years working in the field of environmental science and aquaculture, I returned to continuing education and received a M.S. in Animal Biology (2007) and Ph. D in Ecology (2011) with the University of California, Davis. I have worked in research that spans a wide field of laboratory and field studies. These topics include, but are not limited to, impacts from toxins such as environmental pollutants to toxin producing cyanobacteria blooms, impacts from physical stressors (salinity and temperature), and effects of nutritional stress. I have experience with gross pathology, histopathology, and nutrition and health biomarkers.

My current work with Metropolitan is focused on assessing responses of listed fish species in the California Delta, with focus on Longfin smelt and Delta Smelt, to environmental stressors to better inform water project management and promote sustainable management of listed fish species. My duties include participation on the Longfin smelt Management Analysis and Synthesis Team (Longfin smelt MAST), the Flow Alteration MAST, the Delta Smelt Scoping Team, conducting research and writing manuscripts on Delta smelt, Longfin smelt, and multiple stressors in the San Francisco Estuary. A true and correct copy of my statement of qualifications has been submitted as DWR-1200.

II. OVERVIEW OF TESTIMONY

This rebuttal testimony responds to issues raised by Protestants related to existing conditions for Delta Smelt and allegations that new flows would be effective in providing positive ecosystem changes for Delta smelt. My testimony is in direct response to CSPA (CSPA-202, p.2) testimony that:

> In considering conditions to place on the permits for the SWP and CVP in this proceeding, the Board can and must evaluate conditions for all aspects of SWP and CVP operation, not just those immediately related to the new points of diversion.

My testimony is also responding to issues raised regarding impacts to existing conditions, specifically, CSPA-204, pp. 4, 6 and 28 and 31-32; CSPA-200, errata, pp. 5, 11, and 22-24, NRDC-58, errata, p. 4 and 34-36; April 23, 2018, Transcript, Vol. 32, p. 137-139; CSPA-204, p. 28; April 11, 2018, Transcript, Vol.28, pp. 27, 112, 135-136, and 151-153; April 24, 2018, Transcript, Vol. 33, pp.114-115.

~~I am also responding to several parties whose experts suggested that the SWRCB's 2010 Flow Criteria Report and the SWRCB's Phase II Technical Basis Report recommended standards should be accepted without modification, suggesting that there was no new relevant information that should also be considered. (See e.g., CSPA-202,~~

~~errata, pp. 7-11; April 11, 2018, Transcript, Vol. 28, p. 122; April 24, 2018, Transcript, Vol. 33, pp. 110-115; PCFFA-161, p. 8:7-9.) This is inaccurate.~~ Since 2010, there has been a large body of highly relevant scientific investigation, and this testimony is intended to identify some of that new information. This new information suggests that the 2010 Flow Criteria Report and the Phase II Technical Basis Report should not be accepted by the SWRCB as the best available science without further consideration of current science.

A brief summary of my rebuttal opinions is provided below:

- Opinion 1: The effects of current SWP-CVP operations on Delta smelt are uncertain, and should be managed accordingly.
- Opinion 2: Current Delta smelt proportional entrainment in the SWP-CVP south Delta pumping facilities is low.
- Opinion 3: Opinion 3: The extent that delta smelt abundance is influenced by flow is uncertain.
- Opinion 4: Multiple factors affect Delta smelt distribution.
- Opinion 5: The extent that Delta smelt feeding success is influenced by flow is uncertain.
- Opinion 6: Survey bias should be considered when making management decisions.

III. OPINION 1: THE EFFECTS OF CURRENT SWP-CVP OPERATIONS ON DELTA SMELT ARE UNCERTAIN, AND SHOULD BE MANAGED ACCORDINGLY.

~~Several Protestants stated that the SWP-CVP operations are the primary cause of currently low Delta smelt abundance indices, and therefore additional management of project operations will improve Delta Smelt abundance. I disagree.~~ Many studies demonstrate that the current status of Delta smelt is the result of multiple factors, several of which are unrelated to project operations. (DWR-1242, DWR-1243.). In determining factors affecting abundance, it is important to acknowledge that even where there is evidence of a statistical relationship between abundance of any species and some aspect of flow or water quality, many attributes of flow are cross correlated (meaning they are related). In such cases, further research, including field research, is required to determine which mechanism related to flow is providing the apparent benefit or to determine if the apparent relationship is spurious. (See e.g., DWR-1319 and DWR-1359.)

Current operation of the SWP-CVP can impact Delta Smelt either directly through entrainment (See Section IV, below) or indirectly through changes in flow patterns. (See Section V, VI and VII.) As I explain in my testimony, it is uncertain that further regulation of current SWP-CVP operations targeting direct or indirect would improve Delta smelt abundance.

IV. OPINION 2: CURRENT DELTA SMELT PROPORTIONAL ENTRAINMENT IN THE SWP-CVP SOUTH DELTA PUMPING FACILITIES IS LOW.

Entrainment at the Project pumps was identified as a significant impediment to species viability by NRDC-58, errata, pp.34-36; CSPA-204, p. 4; and April 23, 2018, Transcript, Vol. 32, pp. 138-139. Contrary to the representations of Dr. Rosenfield and others, entrainment in the south Delta pumping facilities post-BiOp is low. Assuming the prescreen losses quantified by Castillo et al 2012 (DWR- 1260) have remained the same, and entrainment has been reduced significantly, you would expect to see trends in Delta smelt abundance improve, but that does not appear to be occurring. (DWR-1243, DWR-1233.) The reason may be that entrainment is not driving species abundance. To evaluate this, entrainment impacts on the species have been tested using several multivariate analyses and these analyses did not support for a population level effect. (DWR-1254, DWR-1255, DWR-1253, DWR-1252.)

The issue of proportional entrainment in the SWP-CVP was most recently

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investigated, and preliminary results reported, in Korman et al. 2018. [1] This analysis suggests that proportional entrainment in 2011, a relatively high abundance year, was an order of magnitude lower than in the early 2000s. [2] (DWR-1259, see also, DWR-1358.) Korman et al utilized state of the art Particle Tracking Models with complex behaviors as well as developing abundance relationships with surveys and salvage data to quantify proportional entrainment. The results of the study suggest that proportional entrainment is low compared to pre-BiOp levels. The lack of improved abundance trends following the reduction in proportional entrainment suggests that entrainment may not be a significant factor affecting the status of Delta Smelt.

Furthermore, to keep Delta smelt away from the south Delta pumping facilities and reduce entrainment even further, DWR and Reclamation have been implementing pre-emptive operational activities based on new studies to reduce Delta smelt movement into the south Delta. Current real-time operations have focused on avoiding the creation of a turbidity bridge that could draw Delta smelt into the south Delta toward the existing pumping facilities. Sediment is mobilized after storms and moves down the Sacramento River. When this occurs, the SWP-CVP reduce pumping at the correct time, which limits the quantity of sediment getting entrained into the south Delta, thereby preventing the formation of a turbidity bridge, thus reducing the probability of Delta smelt entrainment in the SWP-CVP. Additional opportunities for operational flexibility, such as through operations of the CWF, would facilitate further reductions in Delta Smelt entrainment and stabilization of water supplies. To further support this type of flexible operation, a model has been developed from the authors of Grimaldo et al (2017) that can be used predictively to quantify the risk of entrainment in the current SWP-CVP facilities. (DWR-1380.) Project operators can use the information to determine the need for actions to further reduce entrainment risk.

[1] Proportional entrainment is the amount of entrainment at the Water Projects compared to the population abundance.

[2] I acknowledge that low abundance indices may also contribute to low salvage rates.

It is my opinion that as a result of required and voluntary actions current entrainment is already very low and it is unlikely that additional regulation of SWP-CVP operations to further reduce entrainment would improve Delta smelt abundance. .

V. OPINION 3: THE EXTENT THAT DELTA SMELT ABUNDANCE IS INFLUENCED BY FLOW IS UNCERTAIN.

Contrary to the testimony of CSPA-204, p. 28 and 31-32; NRDC-58, errata, p. 4 and 34, April 11, 2018, Transcript, Vol. 28, pp. 27, 112, 135-136, and 151-153, Delta smelt research has not shown a reliable correlation between abundance and winter-spring X2, summer X2, or Fall X2. (DWR-1261, DWR-1262, DWR-1263.) Four multivariate models have been used to test the importance of X2 location and outflow to the Delta smelt population, and all have failed to find support for the conceptual model that Delta smelt population viability was significantly related to the position of X2 or outflow. (DWR-1252, DWR-1253, DWR-1254, DWR-1255, DWR-1265.) As Kimmerer et al. 2009 explained, "…abundance of Delta Smelt did not vary with X2," and, "Adding the previous year's Fall Midwater Trawl as a covariate did not improve the fit of the X2 model for the fall index of Delta smelt abundance." (DWR-1262, pp. 11-12.) Kimmerer et al. 2009 further determined that Delta Smelt abundance was not related to the extent of low salinity habitat (DWR-1262, p. 11-12.). Kimmerer et al. 2009 surmised that while such variables as temperature, tidal velocities or proximity to certain bathymetric features are likely to be important attributes of Delta smelt habitat, they are unlikely to vary with flow in the Delta. (DWR-1262, Kimmerer et al. 2009.)

Dr. Rosenfield (NRDC-58, errata, p. 34; April 24, 2018, Transcript, Vol. 33, pp. 2-3) referenced the analysis in the MAST report that suggests a correlation with flow and summer to fall survival. However, that analysis only used part of the data set. If the whole data set were to be used, there is no relationship between summer to fall survival and flow. Reliance on truncated data was not found to be warranted by Maunder and Deriso (2011) in which they used the whole data set to develop their lifecycle model. (DWR-1254.)

Contrary to the statements of Dr. Rosenfield (NRDC-58, errata, p. 4 and 34 and

NRDC-33 and NRDC-35), there is weak evidence of any relationship between Delta Smelt abundance and summer X2. (DWR-1362.) There are no published and peer reviewed studies that have concluded that there is a relationship between Delta Smelt abundance and summer X2.

The Feyrer et al. 2007[3] model was used in the current FWS BiOp as the main support for the Fall X2 RPA. The Feyrer et al. 2007 model correlated X2salinity, turbidity, and temperature. . When questioned about the Feyrer et al. 2007 paper, Mr. Baxter asserted that fall salinity is related to Delta smelt abundance. (Transcript April 11, 2018, Vol. 28, p.25.) Mr. Baxter did seem to acknowledge the National Academy of Science's critical review of the Fall X2 reasonable and prudent alternative (RPA) that is part of the FWS BiOp. (Transcript April 11, 2018, Vol. 28, p.53-54.) I agree with the National Academy of Science's review of the FallX2 RPA. There are methodological problems with Feyrer et al. 2007 as they used a linear model which is inappropriate for an abundance analysis because it produces unreasonable results that show new Delta smelt recruits even after abundance is zero. (DWR-1264.)

Even if the method was appropriate, the Feyrer et al. 2007 model has low predictive ability. A recent model was developed by Greenwood et al. (2017), based on Feyrer et al (2007). The Greenwood et al. (2017), model predicts the effects of various Fall X2 locations on the survival of Delta Smelt (Fig. 1). (DWR-1265.) The purpose of the analysis was to quantify the change in survival based on changing the position of X2 using the model from Feyrer et al (2007). The analysis found that the Feyrer et al (2007) model only predicted about 25% of the variance across different scenarios. Moreover the model was nearly as likely to predict reduced mortality as it was to predict increased mortality for much of the X2 scenarios. This analysis suggests that Feyrer et al (2007) is an unreliable basis for management actions to improve survival.

[3] Subsequent to the 2008 biological opinion, Feyrer et al. 2011 was published. This study does not investigate an abundance relationship with X2 or outflow. Feyrer et al. 2011 tested various water quality parameters to determine attributes of species habitat.

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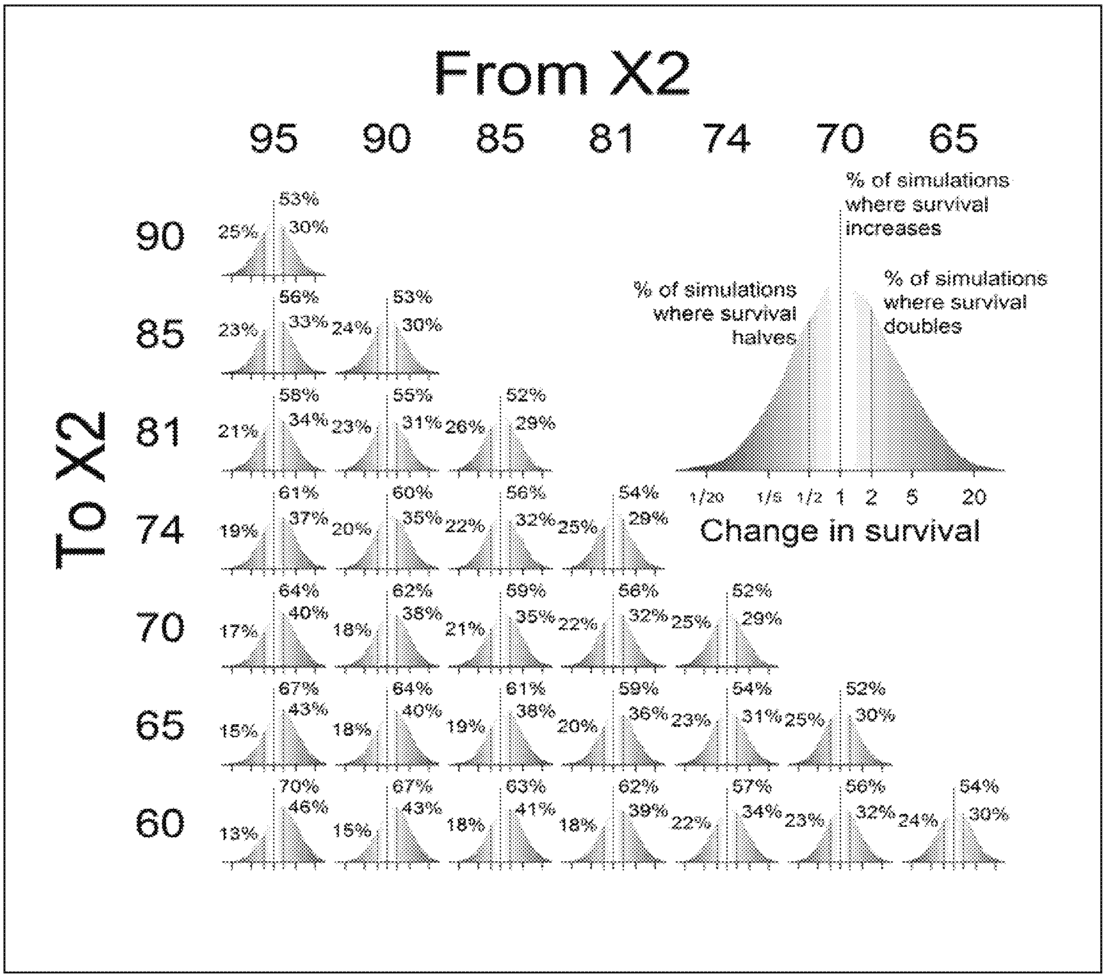

Figure 1. Posterior Density Distributions from 10,000 Simulations of the Change in Delta Smelt Fall to Summer Survival when Fall X2 is Moved from an Upstream Location to a Downstream Location. (DWR-1264.)

VI. OPINION 4: MULITPLE FACTORS AFFECT DELTA SMELT DISTRIBUTION.

Dr. Rosenfield suggested that changes in the location of the low salinity zone could increase entrainment risk. (NRDC-58, errata, pp. 34-36.) The certainty of the previous statement assumes that Delta smelt behavior is simple, however, recent research shows that smelt behavior is much more complex. (DWR-1249, see e.g., DWR-1249.) Previous studies have shown that Delta smelt simply distribute into the LSZ during the juvenile stage and return to freshwater in the adult stage for spawning. (DWR-1266, DWR-1242.) Recent studies have shown that Delta smelt life histories are more complex. (DWR-1243, DWR-

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1268.) Three prevailing life histories have been identified as resident freshwater, resident brackish water, and migratory, although migratory is the dominant life history there have been significant proportions of the populations being residents. (DWR-1268.) This was the case during the high-flow water years (2006 and 2011) and a low-flow water years (2007, 2012, 2013, and 2014) where there was a significant portion (20-48%) of the fish sampled exhibited a resident life history. (DWR-1268.) With certain life histories not showing a relationship with different flow regimes, there isn't support for the conceptual model that suggests that the entire population (i.e. all three life history types) are dependent on the low salinity zone and that flow will help all the Delta smelt redistribute them into the low salinity zone (or that distribution into the LSZ is a benefit for all three life history types).

Delta smelt migratory behavior appears to be related to multiple factors rather than just salinity. This is consistent with Gross et al. 2018 which found that species' distribution is not based solely on turbidity or any other single factor. (DWR-1249, see also, 1269 and 1243.) Gross et al. (2018) investigated Delta Smelt movement using the particle tracking model and found that Delta smelt movement is not simply toward greater turbidity, salinity, nor based on tidal movement. Simulations using simple behaviors such as turbidity seeking resulted in most Delta Smelt going out to the ocean, even though turbidity was lower. Even more complex behaviors such as tidal surfing and turbidity seeking resulted in the Delta smelt rarely entering known spawning region of the Cache Slough Complex, which is where we'd expect them to end up if tidal movement was the predominant factor influencing distribution. Delta smelt distribution being related to multiple factors and not just salinity or turbidity is also consistent with more recent studies which found that Delta smelt were tolerant of a range of salinities, including higher salinities up to 18.5 ppt. (DWR-1244, DWR-1245, DWR-1246.) This means that Delta smelt could seek habitats that have a range of suitable habitat characteristics outside the low salinity zone.

VII. OPINION 5: THE EXTENT THAT DELTA SMELT FEEDING SUCCESS IS INFLUDENCE BY FLOW IS UNCERTAIN

Rosenfield argued that CWF related changes in flow would reduce Delta smelt growth and recruitment through reduced turbidity and food availability. (NRDC-58, pp. 36, and 39-40.) The assumed mechanism with flow and feeding success is that increased flow could improve feeding success by both increasing turbidity and increasing zooplankton densities. There are several concerns with these mechanisms. First, increasing flows to increase turbidity must account for sediment associated contaminants. Contaminants in the Delta can reduce survival of prey, can reduce feeding success, and increase bioenergetics needs. (DWR-1270, DWR-1271, DWR-1272, DWR-1281.) In regards to flows increasing the productivity of zooplankton, *Pseudodiaptomus forbesi*, an important prey of Delta smelt did not increase in productivity in response to flow or increased phytoplankton. (DWR-1273.)

As for higher densities of zooplankton, Hammock et al (2017) found that greater densities of food in the freshwater reaches did not equate to greater gut fullness compared to brackish water that had lower densities and relatively greater gut fullness. (DWR-1244.) This pattern persisted even when accounting for turbidity. This was counter to the prevailing conceptual model involving food and Delta smelt (DWR-1242) suggesting that moving Delta smelt with flow would move Delta smelt to the low salinity zone where feeding success and prey densities are greater. However, Hammock et al. 2017 found that prey densities were higher in freshwater and feeding success was greater downstream of X2. (DWR-1244.) It is suggested that the Project operations are impacting productivity (BiOp 2008) but productivity is higher in the south Delta near the SWP-CVP pumps as compared to much of the San Francisco Estuary. (DWR-1242.) The presence of clams does not readily explain this as the clams are present throughout the Delta (DWR-1274) and productivity is still higher in the south Delta. (DWR-1242.) Flows were suggested to suppress the clams but recent studies seem to indicate that the clam distributions above and below the 2 ppt isohaline will shift with the movement of isohaline. (DWR-1274.) The clams will still be present and mostly just shift their distribution as recruitment success moves with the salinity field. (DWR-1274, DWR-1275, DWR-1276.) The response of the clams to changes in X2 suggest that flow is not good control method.

VIII. OPINION 6: SURVEY BIAS SHOULD BE CONSIDERED WHEN MAKING MANAGEMENT DECISIONS.

The potential for survey bias was raised during the cross examination of Randy Baxter of the Department of Fish and Wildlife. When questioned, Mr. Baxter seemed to suggest that multiple samples during surveys could average out survey bias. (April 11, 2018, Transcript, Vol.28, p. 11.) Mr. Baxter's response does not address the issue of systematic bias.

Survey bias is a statistical term that does not imply intentional bias. It is important to test for survey bias because identifying the biases will help to increase certainty in any conclusions that may be drawn from surveys. (DWR-1238.) Using the raw data without accounting for bias is not recommended. (DWR-1238, DWR-1239, DWR-1240.) Not accounting for bias can end up "leading to spurious conclusions." (DWR-1240.) Only a few published studies have accounted for or considered bias in their analysis of Delta smelt surveys, such as Latour (2016a) and Mahardja et al (2017). (DWR-1241, DWR-1240.)

Neither Latour (2016a) nor Mahardja et al (2017) have suggested that increasing survey station number would correct for bias as was suggested by Mr. Baxter (Transcript April 11, 2018, p. 12:5-13.) Instead Latour (2016a) and Mahardja et al (2017) recommend increasing sampling frequency, accounting for detection bias determined from the higher frequency sampling, and incorporate the bias in the analysis to improve certainty in any conclusions that may be drawn from that data such as abundance. (DWR-1241, DWR-1240.) Latour (2016a) evaluated whether turbidity affected Delta smelt catchability and suggested that it was most likely affecting the detection probability. (DWR-1241.) Mahardja et al (2017) found that size and abundance affected the detection of Delta smelt. (DWR-1240.) For CSAMP/CAMT, Dr. Latour conducted a study on catchability and determined that the Fall Midwater Trawl catch data was affected by the time of day and depth the Spring Kodiak Trawl Delta catch data was affected by. (DWR-1258.) The results suggest that Delta smelt prefer different parts of the water column depending on external factors such as time of day and tide. This was also suggested by Bennett and Burau (2015) and

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Feyrer et al (2013) when they conducted repeated trawls showing that Delta smelt trying to move upstream will move to the sides and bottom of the water column when the tide is out going. (DWR-1248, DWR-1282.)

IX. CONCLUSION

Factors that affect Delta smelt population dynamics have been studied for decades. (DWR-1242, DWR-1243.) Over the last decade, it has been increasingly clear that Delta Smelt life history is complex, and that several factors are interacting to affect Delta Smelt and their habitat in ways we don't fully understand. Much has been discovered but as we uncovered new understandings of how Delta smelt use and respond to their environment many more questions and new conceptual models were formed. What we do know is that our simplistic understanding of Delta smelt is much more nuanced than was described in the conceptual models in the 2008 BiOp.

Executed on this __ day of July, 2018 in Sacramento, California.

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Shawn Acuna

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